3GPP TSG RAN WG1 Meeting #63bis **R1-110385**
Dublin, Ireland, 17th – 21st January, 2011

Agenda item: 6.3.1.3

Source: LG Electronics

Title: Consideration of low-capacity/high-latency backhaul for CoMP

Document for: Discussion and Decision

1. Introduction

Rel-11 LTE system is expected to provide noticeable performance gain using coordinated multipoint transmission (CoMP) operations [1]. However, some practical constraints are imposed on CoMP schemes due to the imperfectness or lack of required channel state information, which are heavily dependent on the latency and limited capacity between coordinated transmission points. This contribution aims to investigate some important constraints on CoMP schemes by reviewing the characteristics of backhaul. The backhaul latency is categorized in [2] as follows:

- Minimal latency (in the order of μs) for eNB to RRH links
- Low latency (<1 ms) associated with co-located cells or cells connected with fibre links and only limited number of routers in between
- Typical inter-cell latency associated with X2 interfaces.

The last one can be considered as a case of low-capacity/high-latency communication link, which includes macro-macro and macro-pico cases with typical X2 interfaces. A macro-femto case without using X2 interfaces can also be considered with constraints from low-capacity/high-latency backhaul.

2. Impact of backhaul link quality on CoMP

The maximum backhaul latency of X2 interface is on the order of 20 ms except some rare scenarios, and typical average latency of 10ms is considered as in [3]. This implies that a transmission point participating in CoMP should operate with latency around 10ms in one-way communication to a coordinating point when low-capacity/high-latency backhaul is adopted. In this case, some existing CoMP schemes which have an iterative nature for information exchanges between transmission points are not appropriate. For example, JP or CB based on handshake between transmission points seems not practical because the actual latency for signal processing at coordinating points becomes multiples of the backhaul latency, which inevitably causes performance degradation due to CSI aging.

Another concern is that QoS is hardly achievable especially for delay-sensitive UEs. Depending on the inter-point communication protocol, a UE cannot be served until its scheduling information is delivered to all the coordinating points or confirmation is returned from all the coordinating points. It causes increased latency and CSI aging problems. Therefore, non-iterative CoMP schemes with one-way signaling seem more practical for low-capacity/high-latency backhaul than iterative CoMP schemes which require information sharing between transmission points in a handshake fashion when low-capacity/high-latency backhaul is adopted.

3. CoMP scheme suitable for slowly coordinating transmission points

Consideration of suitable CoMP schemes under low-capacity/high-latency backhaul needs to be analogous to that of Rel-8/9/10 ICIC. Basically, Rel-8/9 ICIC in LTE is assumed to be conducted in the frequency domain using power allocation information such as RNTP. The RNTP indicator can be

exchanged between eNBs over X2 interface, where each bit of the indicator corresponds to one RB in the frequency domain to inform the neighboring eNBs of the serving eNB's relative transmit power level for the RB. Thus, neighboring cells can utilize the information for estimating the expected level of interference in each RB when scheduling UEs in their own cells. This frequency-domain ICIC scheme has been extended to the time-domain scheme as Rel-10 eICIC with the agreement for X2 signaling in [4]:

- A bitmap pattern is used to indicate Almost Blank Subframe (ABS) pattern of an aggressor cell to a victim cell
- Patterns are semi-statically updated, i.e. not faster than existing Rel-8/9 X2 RNTP signals

This implies that an aggressor cell informs a victim cell of certain ABSs in time-domain manner, and based on this information the victim cell can perform an appropriate user scheduling with RRC signaling to UEs for related RLM/RRM and CSI measurements.

Further possible extension of Rel-8/9/10 ICIC to Rel-11 would be the space-domain coordination, which means an aggressor cell informs a victim cell of certain kinds of beamforming information in space-domain manner, so as to be utilized at a victim cell for appropriate beam avoidance schemes. Regarding CoMP operation similarly, it is also interpreted that a sending point semi-statically determines its precoding and informs the coordinating points of it. This one-way backhaul signaling for such semi-static beam coordination is suitable for CoMP over the low-capacity/high-latency backhaul. By doing so, a receiving point can take advantage of the beamforming information of the sending point to perform its scheduling of UEs.

More specifically, a relevant example for such one-way space-domain coordination can be drawn. Consider one eNB is sending to the next eNB its transmission beam information, which is possibly embedded in backhaul signaling for frequency or time domain ICIC. The receiving eNB may also deliver the beam information to its CoMP UE. Then, the UE can assume the delivered beam information is actually used at the sending eNB, determine its RI/PMI which avoids the delivered beam direction, and calculate the corresponding CQI to be reported. For this one-way coordination, there is no need to do an iterative scheduling or a handshake for UE/PMI coordination.

4. Conclusion

In this contribution, we discussed impacts of low-capacity/high-latency backhaul on CoMP. Finally, we propose:

Proposal: When the transmission points are connected with low-capacity/high-latency backhaul link, DL CoMP scheme should be based on one-way backhaul signaling which allows semi-static transmission beam coordination.

References

[1] R1-101646, Performance evaluation of intra-site DL CoMP, Ericsson, ST-Ericsson.

[2] 3GPP TR36.814 v9.0.0.

[3] R1-071804, Reply LS to R3-070527/R1-071242 on Backhaul (X2 interface) Delay.

[4] R1-105779, Way Forward on time-domain extension of Rel 8/9 backhaul-based ICIC, RAN1.